

Zygapophysial joint pain in selected patients

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Abstract

The zygapophysial joints (z-joints), together with the intervertebral disc, form a functional spine unit. The joints are typical synovial joints with an innervation from two medial branches of the dorsal rami. The joint capsule and the surrounding structures have an extensive nerve supply. The stretching of the capsule and loads being transmitted through the joint can cause

pain. The importance of the z-joints as a pain generator is often underestimated because the prevalence of z-joint pain (10%-80%) is difficult to specify. Z-joint pain is a somatic referred pain. Morning stiffness and pain when moving from a sitting to a standing position are typical. No historic or physical examination variables exist to identify z-joint pain. Also, radiologic findings do not have a diagnostic value for pain from z-joints. The method with the best acceptance for diagnosing z-joint pain is controlled medial branch blocks (MBBs). They are the most validated of all spinal interventions, although false-positive and false-negative results exist and the degree of pain relief after MBBs remains contentious. The prevalence of z-joint pain increases with age, and it often comes along with other pain sources. Degenerative changes are commonly found. Z-joints are often affected by osteoarthritis and inflammatory processes. Often additional factors including synovial cysts, spondylolisthesis, spinal canal stenosis, and injuries are present. The only truly validated treatment is medial branch neurotomy. The available technique vindicates the use of radiofrequency neurotomy provided that the correct technique is used and patients are selected rigorously using controlled blocks.

Key words: Zygapophyseal joint; Facet joint; Low back pain; Medial branch block; Radiofrequency neurotomy; Interventional pain therapy; Chronic pain

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Core tip: This review emphasizes the importance of the zygapophysial joints (z-joints) as a pain generator. Taking the historic or the physical examination are not helpful in identifying z-joint pain. The prevalence of z-joint pain increases with age, and it often comes along with other pain sources. The focus is on the significance of z-joint pain in elaborated patient groups in which z-joint pain is clinically relevant but does not occur as an isolated and independent disease. Diagnostic methods and the treatment with radiofrequency neurotomy are discussed.

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INTRODUCTION

The smallest functional motion consists of two vertebrae, all adjoining ligaments between them, and three joints. First, there is the interbody joint, which consists of the intervertebral disc and the vertebral endplates. The other two joints are the paired zygapophysial joints (z-joints), which are formed by the articulation of the inferior and superior articular processes of two adjacent lumbar vertebra. The nomenclature of the small joints of the vertebral spine is inconsistent. Facet joint is commonly used in North American literature to describe paired synovial joints between the posterior elements of adjacent vertebrae. The joints are also known as z-joints, zygapophyseal joints, apophysial joints, or posterior intervertebral joints. Because a facet is simply a small articular surface and, as such, pertains to any small joint, in this review the term z-joint is used.

The existence of pain deriving from the z-joints is discussed controversially. In the existing literature there is no support for the existence of a facet syndrome. There are no typical examination findings or diagnostic proofs to justify the term "syndrome". Z-joint pain is defined as pain originating from any structure essential to the function and the configuration of the lumbar facet joints, including the capsule, synovial membrane, hyaline cartilage surfaces, and bony articulations^[1].

This review provides an overview about the clinical presentation and treatment of z-joint pain with emphasis on selected patients and diagnosis.

Prevalence

The proposal that the lumbar z-joints might be a source of back pain had initially been communicated more than 100 years ago by Goldthwaith^[2] in 1911. In 1933, the term "facet joint syndrome" was introduced^[3]. With the implementation of successful operations of herniated discs by Mixter^[4] in 1934, the focus was directed away from the z-joints and towards the intervertebral discs. The prevalence of zygapophysial pain is very difficult to specify. In the literature, studies with different prerequisites are found. In original prevalence studies the prevalence was 10%-20%^[5]. Later studies reported prevalence rates of 27%, 31%, 38%, and 45%^[6-9]. The recent investigation by DePalma *et al*^[10] found a prevalence for z-joint pain of 31%. One reason for the incongruity between the different studies is the difference in the age of the groups studied. There is an increasing prevalence with a maximum of more than 40% up to age 70^[10]. In patients with thigh pain, older age was even more predictive of z-joint pain with a predicted probability of more the 50% in 60-year-old

patients and more than 85% in patients over 80 years old^[11].

Anatomy

Although the z-joints are small, they show the features typical of synovial joints^[12]. This means the facets are enclosed by a capsule. The surface of the facets is covered by cartilage, a typical synovium, and even a meniscoid exists. The z-joints of the lumbar spine are innervated from the medial branches of the dorsal rami of the spinal nerves at the same level and from the level above. The medial branch of the dorsal ramus in the lumbar spine runs over the base of the transverse process at the junction of the superior articulating process (Figure 1)^[13-15]. The lumbar dorsal rami have the same number as the vertebra from which they originate. In their course, these nerves traverse structures and innervate joints caudad the segment of origin^[16]. Subsequently, each medial branch passes under the mamillo-accessory ligament^[17]. This ligament is responsible for the consistent location. It can be large and sometimes ossified, particularly at lower levels^[17]. Outside the ligament, the medial branch sends branches to innervate the z-joint, multifidus muscle, interspinal muscles, and the interspinous ligaments^[18]. The z-joints are involved in all principal movements of the spine. Possible movements are axial compression/distraction, flexion/extension, axial rotation and lateral flexion. Horizontal translation does not occur as isolated movement^[19].

Symptoms

Pain originating from the z-joints results from noxious stimulation and is therefore a somatic pain. Z-joint pain is often associated with pain in the buttock or in the leg. However, in this case, it is a somatic referred pain and not a radicular pain. Referred pain occurs because of a misperception of the region of the signal that reaches the brain by a convergent sensory pathway^[20]. Somatic referred pain is perceived deeply. It is diffuse and hard to localize and it is aching in quality^[21]. Pain at the beginning of a movement is typical for joints. Therefore, the z-joints often hurt when moving from a sitting to a standing position or while sleeping when turning from one side to the other. Morning stiffness with difficulty to put on socks in a standing position and pain early in the morning that is relieved during the next hours and with walking will be reported often.

Diagnosis

No historic or physical examination variables exist to identify a z-joint as the pain source^[22,23]. Target joints can be recognized by the pain pattern, local tenderness over the area, and provocation of pain with deep pressure. The neurological examination is usually normal. Pain is the most common reason why patients undergo imaging of the spine^[24], however, the routine use of radiological imaging to diagnose z-joint pain is not supported by evidence in the literature^[25-30]. The majority of

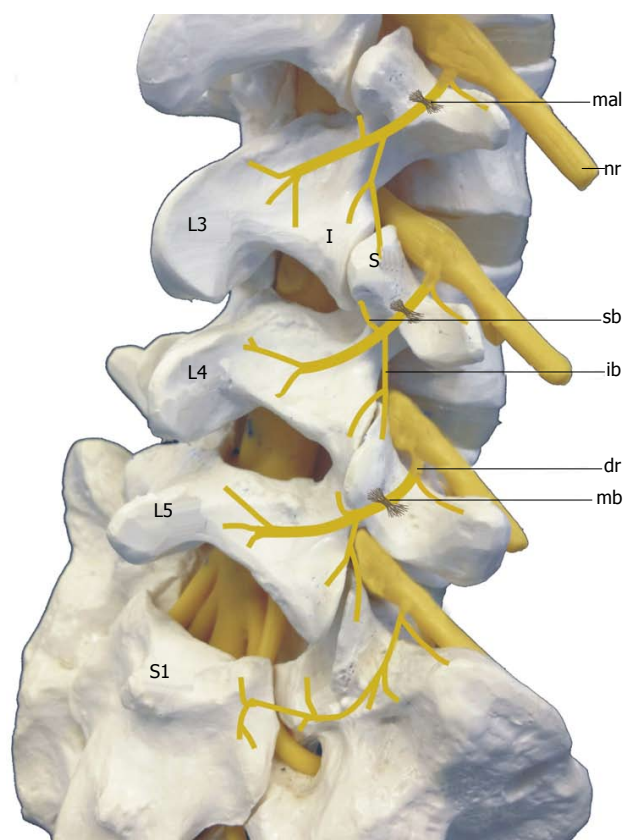


Figure 1 Lumbar medial branch anatomy. Left anterior oblique illustration (L3 to S1): Spinous processes. mal: Millo-accessory ligament; nr: Nerve root; I: Inferior articular process; S: Superior articular process; sb: Superior branch from medial branch; ib: Inferior branch of medial branch; dr: Dorsal ramus; mb: Medial branch^[13,14].

clinical investigations testify no correlation between the clinical symptoms of low back pain and degenerative changes observed on radiological imaging, including radiographs, magnetic resonance imaging (MRI) (Figure 2), computed tomography (CT), single-photon emission computed tomography (SPECT), and radionuclide bone scanning^[28-30]. Specifically, the association between degenerative changes in the lumbar z-joints and symptomatic low back pain remains unclear and is a subject of discussion^[25-28].

The most accepted method^[31] for diagnosing z-joint pain are controlled medial branch blocks (MBBs). MBBs are a diagnostic tool designed to test whether the pain stems from the z-joint because the medial branch innervates it^[32]. They are the most thoroughly validated of all spinal interventional procedures^[33,34]. The target nerve (medial branch of the dorsal ramus) is anaesthetized with a small volume of local anesthetic. The medial branch cannot be regarded as mediating the pain, if the pain is not relieved after a MBBs, this means the z-joint is not the pain source. A new suggestion about the pain source is necessary. If case of a positive answer, the pain source is recognized and a good chance of obtaining pain relief after denervation of the nerve is expected^[35,36]. Single diagnostic blocks are not valid because they have an unacceptable high false-

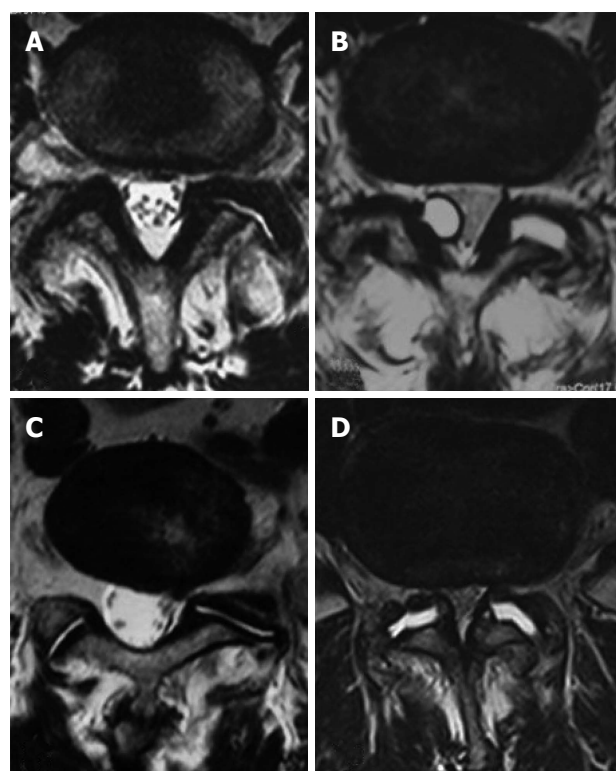


Figure 2 Examples of magnetic resonance imaging findings concerning the zygapophysial joints. A: Degenerative changes; B: Synovial cyst of the z-joint and increased joint volume; C: Asymmetric joint gap; D: Increased joint volume^[13,14]. Z-joint: Zygapophysial joint.

positive rate of 25%-45%^[5-9,31]. To reduce the possibility of responses being false-positive, controlled blocks are mandatory^[29]. Uncontrolled blocks or intra-articular blocks lack validity^[31].

Therapy

No specific conservative treatment for z-joint pain exists. Patients with z-joint pain are treated in the same way as patients with low back pain emerging from a different pain source. Guidelines only exist for radiofrequency denervation of the z-joints, published by the International Spine Intervention Society^[16]. Radiofrequency denervation is the direct consequence after the diagnosis of z-joint pain has been validated by controlled MBBs and it is the only validated treatment for pain mediated by the medial branches^[29]. Percutaneous radiofrequency neurotomy offers pain relief by denervation of the painful joints. It is a percutaneous therapeutic procedure in which a radiofrequency electrode is used to coagulate the medial branches of the lumbar dorsal rami, or the L5 dorsal ramus, in order to relieve back pain mediated by these nerves (Figure 3)^[14].

The available data vindicate the use of lumbar medial branch neurotomy provided that the correct surgical technique is used and patients are selected rigorously using controlled blocks^[16,31]. There are no data that vindicate any other technique^[16]. If the criterion for a positive response to diagnostic blocks is raised to complete relief, some 56% of patients

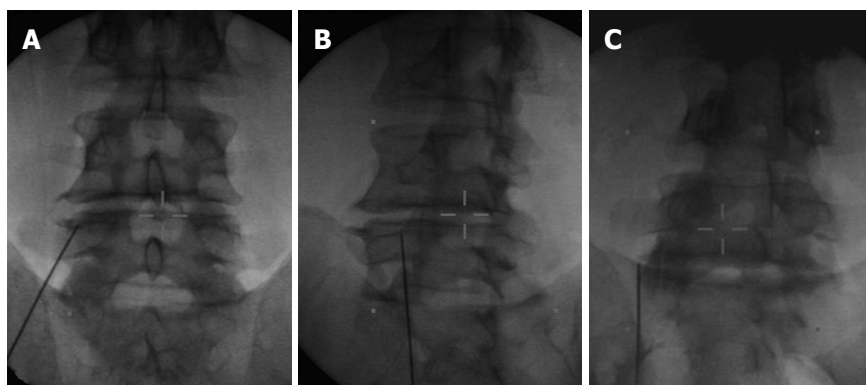


Figure 3 Different views of an electrode placed for an L4 medial branch neurotomy. A: Antero-posterior view; B: Corresponding oblique view; C: Antero-posterior view of an electrode placed for an L5 medial branch neurotomy^[14].

obtain complete relief of pain^[37]. They return to their normal activities, and the need for other health care is eliminated.

SELECTED PATIENTS

Particularly well studied is z-joint pain in patients without comorbidities. In this group of patients, diagnostic standards can be applied best and success rates after a specific therapy can be measured. In this review, the significance of z-joint pain is elaborated in patient groups in which z-joint pain is clinically relevant but does not occur as an isolated and independent disease. It is thus expected that diagnostic and therapeutic methods are only partially successful. For the patients, this can nevertheless make a significant difference in their daily lives.

Degeneration

During life, changes occur to the intervertebral disc and to the z-joints called spondylosis or osteoarthritis. After the fifth decade, the subchondral bone of the z-joint gets thinner^[38]. Severe or repeated pressure may result in erosions and focal thinning of the cartilage (Figure 4). These changes are not a disease per se but an expression of the morphological consequences of stress applied to the disc and the joints during life. The incidence of osteoarthritis is just as great in patients with symptoms as in patients without symptoms^[39,40]. Additional factors must be present to make the z-joints a pain source.

Z-joints are commonly altered by osteoarthritis. The arthritis is usually secondary to disc degeneration or spondylosis^[41], but in 20% of cases it can be totally independent^[42]. This condition is believed to be a possible cause of z-joint pain^[43-46]. Inflammatory mediators, such as cytokines, prostaglandins, and neuropeptides, increase within the joint and the dorsal root ganglion in joint inflammation and arthritis^[47-49]. Specifically, prostaglandin E2 has been identified as a key mediator of inflammation and amplified neuronal excitability^[50-52].

Synovial cysts arise from the z-joint capsule of

the lumbar spine (Figure 2B)^[53]. They contain serous, gelatinous, or hemorrhagic fluid and are sometimes lined with synovium^[54]. The development is related to degenerative spondylosis, segmental instability, and perhaps trauma^[54,55]. They are a cause of back pain and radiculopathy, with z-joint degeneration being the most common cause for cyst formation^[56].

A temporary one-sided load is often found in the context of knee or hip problems with appropriate gait disturbance or when walking with crutches. These patients often develop z-joint pain without structural changes. The reason is unusual strain or overuse of the joint. The treatment prognosis is good. Facet tropism (asymmetry of the facet angles) may have an association with degenerative changes in the spine, either as the cause of degenerative changes or as the result of abnormal loads produced by degeneration^[57]. These degenerative changes can be a cause of back pain^[57]. The clinical significance of facet tropism is not yet well proven^[57-62].

Elderly patient

Degenerative changes are more common in older age. The joints can be affected by osteoarthritis, which is believed to be a possible cause of z-joint pain^[43-46]. Compared with other sources of low back pain (e.g., discogenic pain or sacroiliac joint pain), z-joint pain becomes the most important pain source^[11]. However, there is often an image of mixed pain of various causes. Especially in combination with discogenic changes, spinal canal stenosis and degenerative spondylolisthesis several pain sources might exist.

Spinal canal stenosis

Patients with a spinal canal stenosis on the one hand have a symptomatology coming from the stenosis and the compression of the nerves in the dural sac. These symptoms are called claudicatio spinalis and are manifested in a restricted walking distance with pain, a sensory disturbance in the legs, or even neurologic deficits. On the other hand the most important reason for the development of a spinal canal stenosis is the



Figure 4 Sagittal section through the neuroforamina of a severely degenerated lower lumbar spine of a 70-year-old man. The z-joints are in a subluxated position due to the loss of segmental height. The pars interarticularis of L5 is being eroded superiorly by the inferior articular process of L4 and inferiorly by the superior articular process of S1 (*). Such pars erosion is a prerequisite for the development of degenerative spondylolisthesis. There is no cartilage in the L5/S1 z-joint (arrow heads). Z-joints: Zygapophysial joints.

destruction of the z-joints^[63]. Therefore, patients suffer at the same time from pain deriving from the z-joints. Epidural steroid injections are commonly used to relieve symptoms caused by lumbar spinal stenosis^[64,65]. Treatment of z-joint pain as described above, including radiofrequency neurotomy is an alternative for patients for whom back pain is prominent and for patients with high risk of bleeding^[66].

Spondylolisthesis

The loss of the normal structural support as seen in arthritis of the z-joints is the main local reason that probably leads to the development of degenerative vertebral slippage^[67,68]. It seems to be obvious that morphological deformities of z-joints in the lumbar spine are an important cause of low back pain and segmental instability and a predisposing factor in the development of degenerative spondylolisthesis^[69-71]. One of the most probable sources of pain related to degenerative spondylolisthesis are degenerated and subluxated z-joints and segmental instability which causes tension in the z-joint capsule and ligaments^[67,70]. Spinal instability is often indicated by an increase of the joint volume^[72], or synovial cysts associated with degenerative spondylolisthesis and z-joint osteoarthritis can be found^[73]. An increased amount of fluid in the

joint gap seen on axial MRI (Figure 2D) is significantly suggestive of spondylolisthesis^[74].

It is well known that patients with degenerative spondylolisthesis also have sources of pain other than the z-joints^[75]. In particular, the often additionally present spinal canal stenosis causes symptoms. The second pathology often interlinked with degenerative spondylolisthesis is disk degeneration^[67,68]. Spondylolisthesis is a characteristic example of concurrent pain sources in the same patient at the same time. The proportion by which the z-joints are involved in the complex symptoms is often difficult to diagnose^[76].

Radiofrequency denervation is a rational treatment of low back pain in patients with degenerative spondylolisthesis because morphological deformities of the lumbar z-joints are a predisposing factor in the progress of degenerative spondylolisthesis^[70], pathology of the z-joints is an important cause of low back pain within the lumbar spine^[69]. An adequate pain reduction can be realized in 65% of the treated patients for a reasonable time^[76,77].

Failed back surgery

Z-joints are an important pain source not only in patients with chronic low back pain but also in patients after disc surgery^[78-80]. Therefore, a specific therapy against z-joint pain is rational. Continued pain following lumbar spine surgery has been assumed to be secondary to multiple causes, including epidural fibrosis, acquired stenosis, sacroiliac joint pain, and z-joint pain^[81-83]. It is difficult in post lumbar surgery syndrome to identify pain-generating structures^[84]. The prevalence of z-joint pain in patients with post lumbar laminectomy syndrome is 32%. In patients after disc surgery, the prevalence of z-joint pain is 7% and 28% in patients with persistent back pain after surgery^[79].

The reasons why the z-joints are involved even if the joint was untouched during the operation might be inflammatory processes, low-level trauma, changes in disc height, or stretching of the joint capsule^[23]. The process of degenerative disc disease, particularly when enhanced by a herniated disc or discectomy, results in progressive loss of intervertebral disc volume and disc height and increased load to the joints, which might be a reason for pain^[85]. Z-joint pain can be identified and treated with a radiofrequency neurotomy with a success rate of 58.8%^[79] in patients after disc surgery.

After spinal fusion, z-joint pain can occur due to residual mobility in the index segment or in adjacent segments due to overload. Studies on the effectiveness of a specific joint therapy after spinal fusion do not exist.

Injuries

Z-joint pain is expected to appear with repetitive, chronic strains as might be seen in the elderly, or after an acute incident such as tearing the capsule of the joint by extending it beyond its physiologic limits. This

theory is supported by clinical studies showing a higher prevalence of facet arthropathy in elderly patients^[86-88] and numerous cases of lumbar facet arthropathy after high-energy trauma^[89]. There is also evidence that cervical z-joints can be injured by whiplash injury and can become painful^[90]. Studies using double-blind controlled MBBs found that the prevalence of pain deriving from one or multiple z-joints was between 54% and 60% amongst patients with chronic neck pain after whiplash; 27% of consecutive patients with neck pain and/or headache after whiplash had pain stemming from the C2/3 joint^[91-93]. The level of symptomatic joints is consistent with the location foreseen by biomechanical studies: joints at C5/6 or C6/7 and at C2/3 are most commonly affected^[94-96]. A placebo-controlled trial and several observational studies with long-term follow-up^[97-102] have shown that percutaneous radiofrequency neurotomy can eliminate chronic neck pain after whiplash injury stemming from the z-joints in approximately 70% of treated patients.

Lumbar facet dislocation was reported in more than two dozen patients after rapid deceleration injuries^[89,103-105]. The mechanism of injury in these cases is supposed to be a combination of hyperflexion, distraction, and rotation^[89,103,106,107]. Both in biomechanical studies and in postmortem studies, capsular tears, capsular avulsion, subchondral fractures, intra-articular hemorrhage, and fractures of the articular process have been found^[20,108-112]. Fractures of the z-joints cannot be detected on plain radiographs and might be too small to be seen in CT scans^[111,112]. Lesions such as capsular tears cannot be detected by radiography, CT, or MRI. It may be that these lesions underlie z-joint pain^[1].

CONCLUSION

Z-joints meet all prerequisites to be a pain source. They are often involved in back pain and radiating pain and should not be underestimated. The prevalence of isolated z-joint pain increases with age. In addition, z-joint pain also appears in combination with other common spine diseases, such as disc degeneration, spinal canal stenosis, and spondylolisthesis. If the diagnosis is made with controlled MBBs, radiofrequency denervation is the only validated treatment for pain mediated by the medial branches.

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